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OBSERVING SPICULES ON THE SOLAR DISC

JACQUES BECKERS, *Space Physics Laboratory*, AFCRL

The most spectacular events on the sun are the solar prominences which we view by means of a solar coronagraph. The coronagraph, in effect, creates an artificial eclipse permitting events around the limb of the sun to be seen. Prominences are clouds of low-density solar material which shoot up from the chromosphere or form in place by condensation of coronal material. They have an enormous variety of shapes and sizes, reaching typical heights of 50,000 to 200,000 km. Spicules are less spectacular.

When we view the limb of the sun through a filter which isolates the hydrogen-alpha (Ha) region (6563 angstroms), the chromosphere presents the appearance of a layer of fur. Minute hairy spicules project up out of a fairly homogenous-appearing layer. A typical spicule rises to a height of perhaps 10,000 km in five minutes, and then retracts. The spicules are the only visible means of energy transport from the upper chromosphere into the corona itself, and are probably a factor in generating the intense heating (one to two million degrees C) of the corona.

While spicules are readily observed with a coronagraph around the periphery of the sun, it has not been possible to observe them on the disk--or face--of the sun. If spicules could be observed on the disk, it would be possible to make a much more meaningful count of them--and hence a more meaningful estimate of the total energy they carry. It would also be possible to study their distribution over the solar disk.

Jacques Beckers at AFCRL's Sacramento Peak Observatory has recently determined that the very small elongated dark markings or "fine mottling" observed on the best hydrogen-alpha spectroheliograms of the solar disk were identical with the spicules visible at the limb.

By Doppler measurements, he showed that the dark mottles first rose up from below and then retracted, as the spicules do. In all other observations, it was found that the dark fine mottles behaved like spicules, and the identity of the two seems certain.

It was found that spicules are not randomly distributed, but tend to cluster in "rosettes". These are irregular rings about 15,000 km in diameter composed of radially oriented spicules. They constitute the well-known "course network" of ordinary spectroheliograms. At any one time, there are about 350,000 spicules on the solar surface.

Based on another study of spicules at the Sacramento Peak Observatory, the following picture of a spicule is emerging: the spicule consists of a cool core surrounded by a region of increasing temperature which finally merges with that of the surrounding corona. There is no observational evidence of any pressure differences between the center of the spicule and the corona.

RAINFALL and the phase of the MOON

DR. FRED WARD, *Meteorology Laboratory*, AFCRL

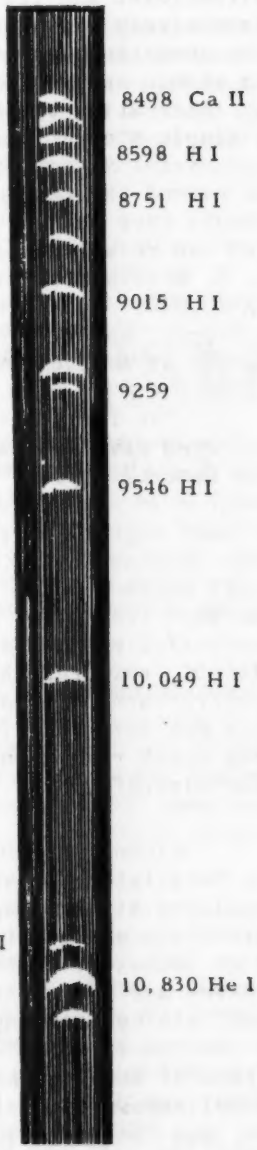
If a correlation could be found between rainfall and the phase of the moon, this would be a discovery of some magnitude. Such a suggestion was made in a report in SCIENCE (137, pp 748-749) in which the conclusion was reached that "precipitation activity over broad areas appears to be closely associated with the monthly lunisolar cycle." In addition, the paper stated that ". . .91-year daily histories of individual stations reveal that heavy rains occur most frequently in the first and third weeks of the synodical month."

This rather startling report carried with it the implication that historical rainfall data from the Boston area would show this potentially important relationship. Since the rainfall data for Boston was near at hand, AFCRL set out to find relationships between rainfall in the Boston area and the lunar cycle. AFCRL scientists analyzed some 1000 dates of heaviest rainfall at Boston in a manner analogous to that described in the report. The 1000 dates covered 92 years of observations, and each date was checked against the phase of the moon at the time.

AFCRL found no correlation between rainfall and the lunar cycle. The mechanism that is discussed in the SCIENCE report apparently does not work in the Boston area. This points up the fact that much research is conducted in the attempt--often unsuccessful--to verify results reported by others.

ARL experiment in the National Geographic Society-Douglas Aircraft Solar Eclipse Expedition

KENNETH E. KISSELL
General Physics Research Laboratory, ARL



Since the flash spectrum was first observed by C.A. Young in the Indian total eclipse of 1870, this striking but evanescent display of the content and the conditions of the solar chromosphere has been studied intensively, first visually and then, after 1893, photographically. The flash spectrum occurs for only a few seconds at most, and is most intense and populous in spectral lines for a fraction of a second when the solar photosphere is just covered by the moon in total eclipse but the lowest layers of the solar chromosphere still remain uncovered. With the disappearance of the glare of photospheric white light, the solar chromospheric light, consisting of thousands of monochromatic emission lines, becomes visible. These emission lines result from energy-level transitions in neutral and ionized atoms existing in layers of lower density and higher temperature within a few thousand kilometers of the visible limb of the sun. Here atoms and ions exist under conditions of equilibrium impossible to produce in the laboratory. Only by the most difficult observations can the brightest of these emission lines be recorded outside of total eclipse using mountain-based coronagraphs and narrow-band filters to produce an artificial obscuration of the sun. It is of interest to note that, since the discovery of the flash spectrum in 1870, the total possible

duration of flash-spectrum observation, if every total eclipse had been observed in clear weather, amounts to only 304 seconds, allowing two seconds at beginning and at end of each eclipse.

During the last three decades, the flash spectrum in the visible, ultraviolet and the near infrared (λ 3000 - 9000A.) has been studied intensively by solar physicists and atomic spectroscopists to learn both the conditions existent in the chromosphere and the relative abundance of atomic species in the sun, and to measure atomic-structure parameters by observation of the relative intensities of lines originating within a single atom at different stages of ionization. Except for a single successful attempt in 1936 by a British expedition to Siberia, attempts to extend the recorded flash spectrum beyond the 9000-Angstrom wave length have been frustrated by weather, the perishability of IR emulsion, and the relatively slow speed of even hypersensitized IR film. In 1936, E. G. Williams obtained a record of 12 emission lines from λ 9000 to λ 10,049. Four lines were identified as due to the Paschen series of hydrogen, and the rest unidentified. The work was not published in detail as to the wave lengths of the unidentified lines.

The first flash spectrum of the sun at the extreme photographic infrared wave lengths from 10,050 to 12,000 Angstroms was obtained by the General Physics Research Laboratory of ARL, as part of its in-house program in atomic spectroscopy. This was done by successfully flying a small objective grating spectrograph utilizing an infrared photoelectric imaging device on the National Geographic Society - Douglas Aircraft Project APEQS flight on 20 July 1963. Utilizing components borrowed from other Air Force and non-AF organizations (in a highly successful example of the flexibility of in-house research), Mr. K. E. Kissell, research physicist at this laboratory, designed a suitable spectrograph after a decision was made to proceed with the experiment. This was less than 70 days prior to delivery of the equipment to the Long Beach rendezvous point for installation in a specially modified DC-8 aircraft.

Kissell and D. F. Frank, experimental-electronics technician in the Metallurgy Research Laboratory, ARL, utilized a conventional triple-regulated high-voltage power supply loaned by the Electro-Optical Surveillance Facility of ASD at Cloudcroft, New Mexico, to provide the 12 KV necessary to energize the image tube. An infrared reflection grating was loaned by Dr. B. A. Kulp of ARL. The ITT infrared image tube, Alnico focusing magnet, and necessary camera lenses were loaned by the Committee on Image Tubes for Telescopes of the Carnegie Institution of Washington. Other assisting organizations which provided miscellaneous optical parts were the Technical Photographic Division, ASD, and the McMillin Observatory at Ohio State University. The spectrograph and supporting mount were fabricated by Messrs. Grube and Ross, of the ARL Technical Support Branch. By modifying an earlier IR camera system built by Mr. Sheffield of the Technical Support Branch,

and used by Mr. Kissell at Lowell Observatory for stellar IR spectroscopy, a rugged, flyable instrument was built in less than 30 days at an expenditure of less than $100 for components.

The apparatus was flown to Long Beach ten days in advance of the eclipse and installed by Douglas personnel in the privately leased Delta Air Lines DC-8 aircraft. Most of the windows on the right-hand side of the aircraft were replaced by flat, recessed glass windows with special provisions for suppression of water condensation. This made it possible to record the eclipse at its 48-degree elevation angle while observing perpendicularly to the optical quality windows.

The eclipse flight took place from Edmonton, Alberta after a practice mission on the previous day. The image tube was cooled to dry-ice temperatures after take-off to suppress the thermal dark current from the photocathode. The eclipse shadow was intercepted over Fort Providence, Northwest Territories only one second earlier than anticipated, with the sun immediately athwartships. Cruise altitude was 40,100 ft. at a ground speed of 525 mph. This velocity parallel to the shadow motion gave a totality of 142 seconds compared to 100 seconds for ground-based observers. A special Sperry autopilot placed the aircraft on inertial reference from totality minus 2 minutes till totality plus 8 minutes with a stability of approximately 0.3 degrees in roll and 0.1 degree in yaw. As the result of the rather small aircraft motion, the quality of the flash spectra ranged from excellent to fair depending on the exposure time and the rate of aircraft motion during exposure.

In the parlance of eclipse astronomy, the flash spectrum occurs at second and third contact, i.e., the second time and third time a limb of the moon contacts a limb of the sun (beginning and end of totality of a total eclipse). Four spectra were obtained at second contact, and two spectra at third contact. One badly blurred coronal spectrum was obtained during mid-eclipse, which was heavily overexposed in six seconds.

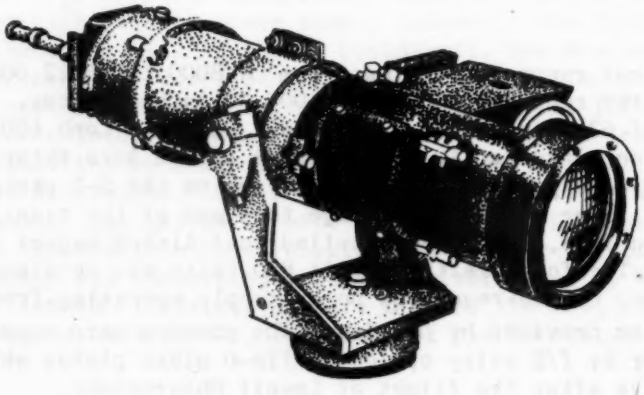
The spectral range covered was from λ 8000 to λ 12,000 Angstroms, with the region λ 8500 to 11,000 A. in best focus. The spectrograph, of 63-mm aperture, utilized a Bausch & Lomb 600 line/mm reflection grating blazed at 10,000 A. and a 178-mm Aero Ektar for the camera. This yielded a plate scale of 90 A. /mm on the S-1 photocathode of an FW-167 ITT image tube. The image tube was of the single-stage magnetic-focusing type, employing a cylindrical Alnico magnet for the focusing field. The focus voltage of 11,850 volts was obtained from a standard 60-cycle, triple-regulated power supply operating from a 5-KW air-borne inverter provided by Douglas. The spectra were recorded from the blue phosphor by f/2 relay optics on IIa-O glass plates which were processed two days after the flight at Lowell Observatory.

The most notable features recorded by Kissell and Frank are the Paschen lines of hydrogen from H6 at 10,938 to H14 at 8598 A. (H13, H15 and H16 are obscured by the singly ionized calcium triplet at 8498, 8542 and 8662) and the He I line at 10,830. As indicated in the leading illustration, features are visible at approximately 9259 and 10,746. The 10,746 line is tentatively identified as Fe XIII. On the original plate, an additional weak feature near 10,800 is probably the companion Fe XIII line at 10,798 A. Spectra taken at third contact, after the end of totality, clearly show sharp lines at approximately 10,327 A. due to ionized strontium or iron, perhaps, and a doublet at 10,684 and 10,691 A. possibly due to neutral carbon. Some 30 to 35 emission lines are recorded in these latter spectra, nineteen of them redward of 9000 A. This is believed to be the first flash spectrum obtained in the wave-length regions beyond 10,050 A. and one of the first beyond 9000 A. Precise measurements of the plates are in progress.

The spectra will serve several purposes. The first is the obvious establishment of the IR image tube, in its already developed forms, as a suitable tool for air-borne research studies. The usage of a permanent magnet for the focusing magnetic field and dry ice as a coolant proved quite adequate in the aircraft environment.

Measurement of the wave lengths of the hitherto-unobserved lines in conjunction with their angular arc length and the energy levels of the upper states of the possible elements or ions of origin should lead to positive identification of their source and the altitude of the source atoms in the solar atmosphere. It is from such new results that progress is made in knowledge of the atomic states excited in the upper layers of the sun.

The complete interpretation of the recorded spectra will lead to better understanding of the atomic processes in the upper layers of the sun and possibly to a better understanding of the atoms themselves, since the intensities of the observed lines are functions of the atomic parameters governing collisional and radiative energy exchange by the atoms.



three eighty-two

MAJOR BERNARD S. MORGAN JR., *Applied Mathematics Division, AFOSR*

"Three Eighty-Two" has been retired after a most complete and satisfying career. It helped us catch up with and overtake the Russians in one of their own specialties and established us as world leaders. "Three Eighty-Two" is contract AF 49(638)-382, "The Study of Nonlinear Mechanics."

Under the contract, emphasis has been placed on the study of ordinary differential equations. Such equations have contact with all sorts of applications. The dynamic motion of an aircraft, the operation of electronic circuits, etc., can be described by ordinary differential equations. This contract was initiated in 1958, a few months after Doctors Solomon Lefschetz and Joseph LaSalle had established a center for the study of differential equations at the Martin Marietta Corporation's Research Institute for Advanced Studies (RIAS) in Baltimore, Maryland. Fundamental backing and support for the center came from AFOSR. This organization is now known as the Mathematics Center and is supported under Contract AF 49(638)-1242.

From the beginning, much of the research work at the Center has been done on the Liapunov stability theory which has been more or less ignored outside of the Soviet Union. (In the Soviet Union itself, this theory has achieved virtual pre-eminence as the principal mathematical tool in tackling linear and nonlinear stability problems, particularly in the theory of control systems). The book by LaSalle and Lefschetz [1] and the article by Kalman and Bertram [2] have done much to interest applied mathematicians and engineers in the general theory, as well as to add significantly to the theory. Many noteworthy contributions to the mathematical theory of automatic control have also been made, particularly in optimal control and filtering theory. Finally, an obviously important branch of differential equations, the theory of oscillations and approximations, has been pushed strongly. An excellent exposition of this work has appeared recently in the book by Hale [3]. The Mathematics Center is now a world leader in these fields.

Details of the accomplishments under "Three Eighty-Two" can be found in a recently published AFOSR report [4]. Summaries of research results on Asymptotic Behavior, Functional-Differential Equations, Stability of Dynamic Systems, Mathematical Theory of Control, Qualitative Theory of Differential Equations and Control Theory are included.

The report also lists the 140 papers and 11 books supported under the contract.

1 LaSalle, J. and S. Lefschetz, STABILITY BY LIAPUNOV'S SECOND METHOD WITH APPLICATIONS, Academic Press, New York, 1961.

2 Kalman, R. and J. Bertram, "Control Systems Analysis and Design via the 'Second Method' of Liapunov, I. Continuous-Time Systems; II. Discrete-Time Systems," J. BASIC ENGR. Vol 82, 1960, pp 371 and 394.

3 Hale, J. K., OSCILLATIONS IN NONLINEAR SYSTEMS, McGraw-Hill Book Company, N. Y., 1963.

4 Lefschetz, S. and J. LaSalle, AFOSR 5130, FINAL REPORT, "Study of Nonlinear Mechanics, 31 Mar 58 - 31 Mar 63."

after Arecibo...

DR. ALAN C. SCHELL, *Microwave Physics Laboratory*, AFCRL

On November 1, 1963, the world's most powerful antenna, the 1000-ft-diameter radar-radio telescope at Arecibo, Puerto Rico was dedicated. Even as the Arecibo telescope is placed in operation, a new and even larger antenna is being planned by AFCRL. This is the multiplate antenna which has been designed as a space-surveillance and tracking radar system, and as an extremely powerful radiotelescope.

Theoretical work on this new antenna began at AFCRL in 1960. This was followed by the construction of a test section of the multiplate antenna in 1962 at an AFCRL test site. This test section is a sizable antenna in its own right, covering an area of 70 by 120 feet. Operation of this test section over a one-year period has proved exceptionally rewarding. Quantitative data--firm figures--show that an antenna of the multiplate type is capable of performance within one per cent of design value.

First let us describe the proposed multiplate antenna, and then compare its projected performance with the performance of the 1000-ft. Arecibo telescope and a conventional 84-ft. telescope. The multiplate antenna consists of approximately 5000 flat plates, each of which measures 20 by 20 feet, arranged in four elliptical areas around a central tower. In the center, a circular area of 100-ft. diameter contains no plates, allowing ample room for the tower base. The tower is 1000 feet high and holds a feed platform that is maintained in position by guy cables and a servomechanism. This quadriellipse configuration provides a maximum aperture distance of 2500 feet in two planes, with an aperture area that is equivalent to a 1600-foot diameter dish. Each plate is adjustable in height and orientation to redirect energy from

an arbitrary direction to the focus with the proper phase. A computer is used to determine the proper tilt angle and center height of each plate.

The multiplate concept grew out of the need for greater and greater sensitivities of the kind that can only be achieved by larger collecting areas. For fully equatorially mounted radiotelescope dishes, engineering and economic considerations limit dish size to about 300 feet, which is the size of the recently completed telescope at the National Radio Astronomy Observatory at Greenbank, West Virginia. With Arecibo these limitations are overcome, but flexibility is lost. Such dishes carved out of a natural depression can scan only over a limited area. Their location is governed to some extent by the location of useful natural depressions.

The important feature of the multiplate concept is that the antenna can be built to any arbitrary size, with construction costs increasing linearly with area. With fully steerable dishes, costs increase exponentially with size. However, one concern in the design of an antenna of the multiplate type was the effect of the apparent temperature of the antenna. This is a measure of the amount of thermal energy that is radiated from the ground and diffracts around the plates into the feed horn. The result of this is a decrease in antenna gain. Data recorded at the AFCRL test section using Cygnus A as the radio source shows this loss in gain to be lower than feared.

Operating in the radar mode with a 2.5 Mw L-band transmitter, the antenna in the proposed plan can detect targets of one square meter at 80,000 miles. (An 84-foot-diameter dish with a similar transmitter would provide detection ranges of one square meter at 4000 miles, and the Arecibo telescope, which operates at 430 Mcps, at 26,000 miles). This extreme sensitivity is perhaps better appreciated by a comparison at a range of 15,000 miles. At this distance the minimum cross section seen by the 84-foot antenna system is 200 square meters; for Arecibo it is one tenth of a square meter; that of the multiplate antenna is one thousandth of a square meter. This factor of over 10,000 and 100, respectively, in performance, makes this antenna a radical new tool in the Air Force inventory. Indeed, this antenna can discern details of the moon's surface with the same resolution as the human eye. Thus, a radar map of the moon could be made that is as detailed as what one sees. When this is compared to the usual radar display or series of spots on a screen, some awareness of the tremendous resolution increase can be gained.

Within the past year, $250,000 was spent for a number of special studies of the multiplate antenna. These studies are concerned with the optimum size of the square plates from the standpoint of performance and economy, the stability of the thousand-foot tower on which the feed system will rest, and the design of the antenna control system--that is, a system for automatically aligning all the plates with respect to the tower for scanning.

antireflection lens in *INSECTS*

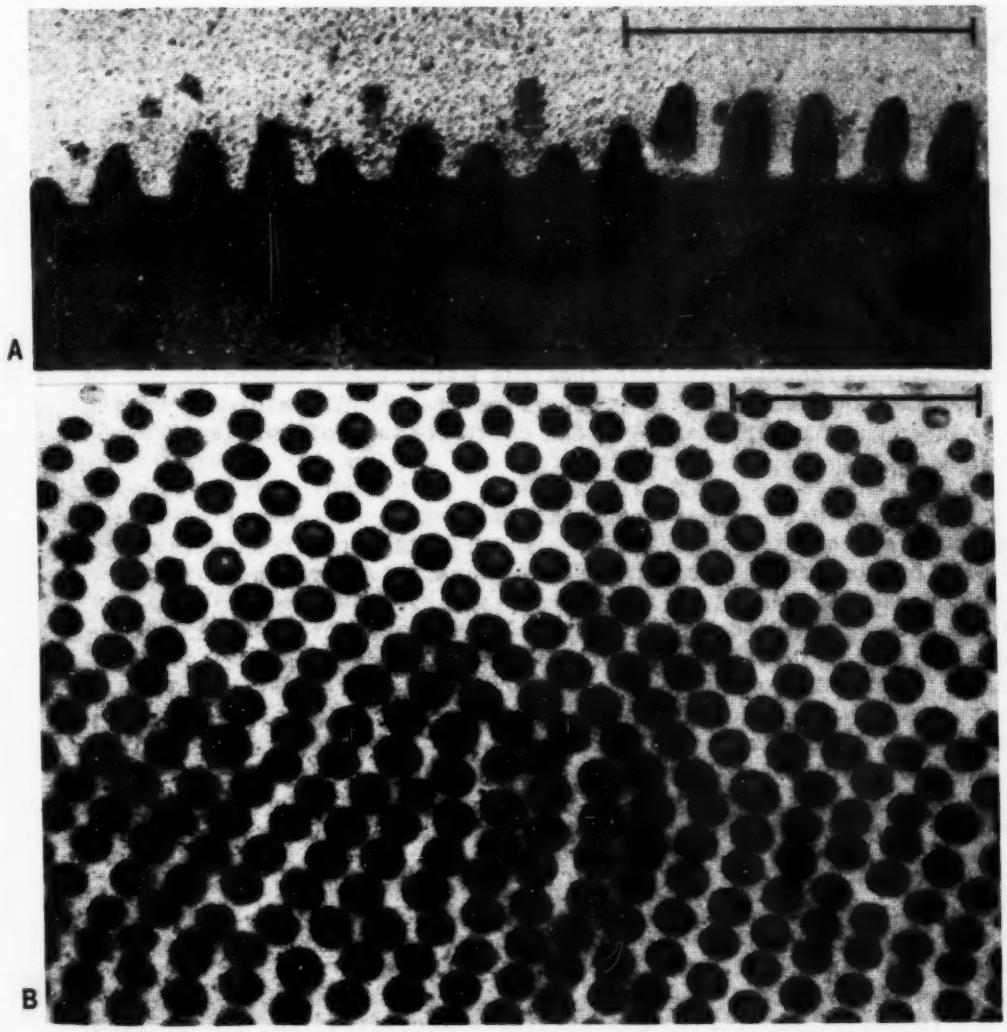
HARVEY E. SAVELY, *Directorate of Life Sciences, AFOSR*

Professor C. G. Bernhard and his group in the Karolinska Institute, Stockholm (AF-EOAR Grant 63-7), have been studying vision in compound eyes which are characteristic of insects and crustaceans. When they were examining some electron-micrographs of the eye of a nocturnal moth, they discovered that the cornea (outer surface of the lens) was not a smooth surface as expected, but was made up of a hexagonal array of submicroscopic cone-shaped protuberances about one fourth of a micron in elevation. This curious design stimulated their desire to learn if this was an accident of nature or if these nipples, as we may call them, might have some functional significance. It turned out that this was a remarkable way to reduce reflection from the lens and consequently to increase light transmission. Professor Bernhard's group arrived at this conclusion both on theoretical grounds and from experimental studies.

In one series of studies an appropriately scaled dielectric model of the lens was made and then tested for microwave transmission to simulate a light-lens system. These tests showed that there is a peaking of optical density of about 1.5 log units where the wave length is one half the nipple height. This turned out to be in a region of the ultraviolet spectrum where no energy reaches the earth. But at longer wave lengths in the visible and near-ultraviolet region of the spectrum, microwave experiments indicated that the nipples caused a marked decrease in reflection from the front surface of the cornea. Direct observations of the insect cornea agreed with the model experiments in showing that the presence of nipples decreased reflection over a wide range of wave lengths.

The nipples do not impair the transparency of the lens. By reducing reflection, the nipples have the same function as man-made lens coatings. An optimal coating for a lens would be one which made a gradual transition between the index of refraction of air and that of the lens. Because this cannot be achieved practically, the best approximation is achieved by application of a coating of homogenous material of low refractive index. For wave lengths close to four times the thickness of the coating, reflection will be substantially reduced.

The insect has come nearer to achieving an ideal "coating" since the nippled surface gives antireflection over a broad range of wave lengths. This is apparently because the nipples, and the air spaces between them, provide a gradual transition in refractive index between air and the cornea. By reduction of reflection from the corneal surface, the nipples improve camouflage without impairing visual acuity. In fact,



Electron micrographs of corneal nipple pattern in the southern army-worm moth (Prodenia eridiana). A. Section normal to corneal facet surface. B. Section tangent to corneal facet and slightly above the surface. Scale 1μ in both micrographs.

from Karolinska Institutet, Stockholm
C. G. Bernhard and William H. Miller

there is a slight increase in light transmission. All of these factors are important for survival in a nocturnal insect.

The investigators are now looking into the possibility that this discovery may represent an invention of "a nonresonant dielectric impedance transformer of easy construction" of special interest in the microwave field. They are also following up other leads opened up by these investigations.

DOCUMENTATION: handmaiden to science

ROWENA W. SWANSON, *Information Research Division*, AFOSR

Scientific progress depends, at least in part, on the time a scientist has to think and to explore his thoughts on paper or in the laboratory. "Progress" implies that his efforts add something new to the state of knowledge. This presupposes that he is informed, during his thinking and exploration, of the current state of knowledge on his problem.

The increasing importance being placed on documentation activities rests on the assumption that such activities can reduce the time expended by a scientist in the nonproductive but essential task of keeping himself informed of the current state of knowledge in his problem area. Irrespective of reasons or motives for today's literature explosion (e.g., "publish or perish" policies), the volume of scientific publication (e.g., 2×10^6 articles/year[1]) far exceeds the bounds that can be individually screened and evaluated. In his attempt to strike a balance between keeping informed and conducting research, the scientist tends to limit his reading to a few major journals in his field.[2] In at least one discipline (biology), this practice has been shown to be very inadequate.[3]

The AFOSR research program in the Information Sciences is directed toward the evolution of systems, procedures, and techniques by which information can be made available to scientists efficiently. An objective is to relieve the scientist from the necessity of acting as his own documentalist. It should be possible for an information service to tailor reports to a scientist's specifications for information to maximize the effectiveness of his read-and-study time.

At the Institute of Experimental Medicine and Surgery, University of Montreal, value to the research scientist of several documentation activities is being investigated.[4] The Institute, under the direction of Dr. Hans Selye, is an internationally known center for research in endocrinology, stress, calciphylaxis, and the anaphylactoid reaction. The research staff is served by a library whose collection is organized, for subject control, in accordance with a unique system called the Symbolic Shorthand System.[5] The library, with over 500,000 entries and receipts averaging 30,000 items per year, has also served as an information source for the scientific community in the areas of its specialization ever since its inception in 1945.

The evaluation of documentalists as support personnel to scientists was started more from accident than from design. In February 1962, the research library lost part of its collection and index in a fire. It received literature donations and funds to assist in its reconstitution.[6] Assembling a staff to analyze new and replaced documents became the responsibility of Mr. George Ember, chief of the documentation department. (This task had been performed by the research staff, but became insurmountable under the increased load.) Such staffing problems are grim. An information system, in the final analysis, is no better than the quality of its input. Input to the Institute's system had to be accurate, comprehensive, and consistent, for maximum effectiveness. Mr. Ember sought to accomplish system objectives with nonscientist personnel.

The Symbolic Shorthand System is proving itself capable of being applied by a nonmedically trained staff. The System is a set of rules which specify (a) a symbolism for representing experimental observations and procedures;[7] and (b) a fixed order of precedence for storing the symbolic representations in an index file. Mr. Ember has found that persons with a nonscientific education can learn to extract salient facts and procedures from medical papers and convert this information into Symbolic Shorthand form. Knowledge of languages is one of the most valuable staff assets. The present staff has a competence in 16 languages.

Success of the staff in document analysis led Mr. Ember to explore their adaptability to other operations. Must file searching and the preparation of answers to subject questions be done by a scientist? Mr. Ember has found that inquiries from the Institute's research staff and from members of the scientific community can be processed by the documentalists. The question can be analyzed and coded in the same manner as document information is processed, and the symbolic representations can be matched against those in the file. Similarly, documentalists can prepare bibliographies on topics which can be symbolically represented. The assembly of references for monograph preparation by research scientists is also contemplated as a task for documentalists.

The nonscientifically trained documentalist can thus have an important role in the saga of science. He must be able to analyze what he reads and logically order it in accordance with an indexing system structure. Parenthetically, of course, the indexing system must be logically ordered and amenable to comprehension by the nonscientist. Given these two requirements, on man and system, it appears possible to relieve the scientist of much of his unproductive reading load. Scientists' information needs are creating the possibilities for a new profession which can exploit the analytical and intellectual skills of nonscientists. It is envisioned that much of information processing can eventually be automated; but machine programs for intellectual operations -- the ability of a machine to develop the insight to figuratively record "aha!" -- are goals for the future. The man-man symbiosis being explored at

the Institute of Experimental Medicine and Surgery is an information-system goal apparently achievable now.

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1. Senders, John W. "Information Storage Requirements for the Contents of the World's Libraries," SCIENCE, Vol. 141, no. 3585 (13 Sep 1963), p. 1058, footnote 6.

2. Marron, Harvey, "Science Libraries, Consolidated/Departmental?" PHYSICS TODAY, Vol. 16, no. 7 (Jul 1963), pp. 34-36.

3. Ibid., p. 35 and footnote 7.

4. Grant AF-AFOSR-62-356.

5. Selye, Hans and Plinio Prioreschi. SYMBOLIC SHORTHAND SYSTEM FOR PHYSIOLOGY AND MEDICINE. Acta Inc., Montreal, Canada, 3rd ed., 1960.

6. Assisted by the National Library of Medicine, the Institute received credits with the U.S. Book Exchange enabling much journal replacement. Appeals to cultural attaches in Ottawa resulted in many donations, including a 1,000-journal and 400-book shipment from the U.S.S.R. Academy of Sciences. Approximately 5,000 books, 250,000 journals, and 100,000 reprints were received; but 75,000 to 100,000 of the original documents must still be replaced.

   The Life Sciences Group, DCS/R&T, U.S. Air Force was the first to provide modest financial assistance. Support has subsequently been received from the National Institutes of Health, the National Science Foundation, the Gustavus and Louise Pfeiffer Research Foundation, the Medical Research Council (Canada), the Department of Health (Canada), and private sources.

7. Rules of the Symbolic Shorthand System provide for the representation, by letters, numbers, and signs, in sentence fashion, of observed facts and experimental procedures. A separate sentence is required for each target of an experiment (i.e., an organ, condition, biological event, or chemical component of the body). Agents, conditions, and their effects on the target are recorded in a fixed order of precedence in the symbolic statement. For example, a study concerned with the induction of uterine contractions (U-c) by combined treatment with oxytocin (OX) and progesterone (PROG) in immature (Age ↓) guinea pigs (Gp) is represented by the statment

   $$\text{U-c} \leftarrow \text{OX} + \text{PROG} + \text{Age}\downarrow/\text{Gp}.$$

   From Padmanabhan, N. and G. Ember, "Symbolic Shorthand System for Physiology and Medicine," METHODIK DER INFORMATION IN DER MEDIZIN, Vol. 1, no. 4 (Oct 1962) pp. 138-142.

to our readers

Requests for further information should be directed to the individual or laboratory of origin (except for those from Latin America).

Addresses are as follows:

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Laurence G. Hanscom Field, Bedford, Massachusetts 01731

AEROSPACE RESEARCH LABORATORIES
Attn: ARB
Wright-Patterson Air Force Base, Ohio 45433

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
Attn: SRIL-2
Tempo D Building
4th and Independence Avenue, S.W., Washington, D. C. 20333

OFFICE OF RESEARCH ANALYSES
Attn: ORR
Holloman AF Base, New Mexico 88330

Requests for further information from institutions and individuals in Latin America should be addressed to:

LATIN AMERICAN OFFICE AEROSPACE RESEARCH
U. S. Embassy
Rio de Janeiro, Brazil

Detailed documentary reports may be obtained from:

OFFICE OF TECHNICAL SERVICES
U.S. Department of Commerce, Washington, D. C. 20230

DEFENSE DOCUMENTATION CENTER FOR SCIENTIFIC AND TECHNICAL INFORMATION *
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